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Home Course In Modern Agriculture

IV.—Water In Its Relation to Plant Growth

By C. V. GREGORY,

Agricultural Division, Iowa State College

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WE have already learned something of the value of water as a plant food. This is only one of its minor uses, however. In addition to the water which is decomposed by the plant and used in making starch and other products, many times as much is used for other purposes. One of the principal of these is dissolving plant food and carrying it upward to the leaves. After reaching the leaves most of the water is evaporated, leaving in the leaf cells the materials which it brought up.

The cells of which the leaves are made are very delicate and depend for their stiffness on the water which they contain. Without this water they would collapse in the same way a bicycle tire does when the air is let out. This is the very thing that happens when the leaves wilt. The rise of water from the roots has been checked in some way, and as evaporation still continues the leaf cells become partly emptied and shrink up.

The leaves are not entirely helpless at such a time, however. On each side of the tiny pores on the underside of the leaf is a cell known as a guard cell. When the supply of moisture begins to fail, these guard cells shrink up and in doing so close the openings, thus checking evaporation. In some plants, like corn, the leaves curl up at such a time, thus still further lessening the rate of evaporation. Of course when a leaf is wilted in this manner the work of building up plant tissues is seriously checked. This often happens during the dry weather of July and August, when the soil becomes so dry that the roots have difficulty in obtaining the needed moisture. The checking of development which results often reduces the yield of corn as much as twenty to thirty bushels per acre and that of other crops in proportion. For every pound of dry matter in a mature plant from 300 to 500 pounds of water have been brought up by the roots and evaporated from the leaves. One of the most important factors in the production of a maximum crop is the maintenance of a plentiful water supply within easy reach of the roots.

There are three classes of water in the soil. The first is known as ground water and is that water which collects in a hole dug in a wet soil or runs off through the tile is drained

land. The second is the capillary water and is that which is left between the soil particles after the ground water has been drawn off. The ground water is affected by gravitation, while the capillary water is not.

If a sample of soil that looks perfectly dry is placed in an oven and heated for some time it will be found that it has lost considerably in weight, owing to moisture being driven off. This is the third class, or hygroscopic moisture. This, of course, is of no value to the plant, since the roots cannot extract moisture from an air dry soil. Neither can they use the ground water. This is really a damage in the upper two or three feet of soil, above it so fills the spaces that the roots cannot get enough air.

During a rain the ground water passing through the soil draws considerable air with it. As soon as the

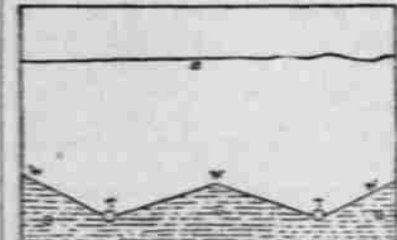


FIG. VIII.—HOW TILE DRAINS AFFECT THE WATER TABLE.

(S, surface of the ground; W, water table; G, ground water; T, the drain.)

soil becomes saturated, however, so that the water is no longer moving, the air soon becomes used up, and the crop will turn yellow and cease to grow. The remedy, of course, is to provide drains to remove the ground water quickly.

The only kind of water which the roots can use is the capillary water. When this is present in the right amount, it fills about half of the spaces between the soil particles. The rest are filled with air. The water easily dissolves plant food from the soil grains which it surrounds. Thus the two essentials for rapid root development, air and plant food, are present in the proper amounts and in a readily available form. As fast as the water is taken up by the roots more is brought up by capillarity from the supply in the subsoil in the manner noted in article No. 2.

The place where the capillary water joins the ground water is called the water table. If this water table is too high, the feeding ground of the roots is greatly restricted, since they cannot go below it. If, on the other hand, the water table is too deep, capillarity cannot bring the water up as fast as it is used by the roots.

In dry weather the water table lowers rapidly, but the roots are also growing downward at the same time. The greatest damage from drought comes when a sudden dry period follows a few weeks of excessive rainfall. The abundance of moisture during the early part of the season has kept the plants from sending their roots down very deep. When dry weather does come, the soil bakes and cracks and evaporation goes on very rapidly. This, together with the demands made by the plants, lowers the water table so rapidly that root growth cannot keep pace with it. As a result the capillary moisture within reach of the roots is not replaced as fast as it is used, and the growth of the plants is seriously checked.

Fields with a clay subsoil withstand dry weather much better than those with a subsoil of sand or gravel. The latter, because of their looser texture,



FIG. IX.—COVERING THE TILE DITCH.

allow the water to filter down out of reach instead of retaining it for future use, as do the clay soils.

The farmer cannot influence the amount of rainfall, of course. After the rain has fallen, however, it belongs to him to do with as he sees fit.

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The way he handles it from this time on determines to a large extent the size of the crop he will harvest when fall comes.

The first problem is to get rid of the surplus ground water quickly, and the second is to waste as little of the capillary water as possible. An endeavor should be made to lower the water table to three or four feet below the surface as soon as possible after each rain. If this can be accomplished in two or three days the growth of the crop will be interfered with very little. A few soils are so well drained naturally that little artificial drainage is necessary. On almost any farm there are hills and ridges where the natural drainage is sufficient. The hollows between these elevations, however, and all the flat fields will yield much larger crops if tiled.

The distance a line of tile will "draw" is in sandy soils often as far as 100 feet on each side, while in heavy clay soils it may not be more than sixteen feet. This distance is also affected by the depth of the tile. The deeper they are placed the farther they will draw. Tile are usually placed at an average depth of about three feet, though in many instances four would be better. The extra cost of digging the ditch a foot deeper is something of an objection, but is balanced by the fact that the lines of tile do not need to be as close together. Deep tile are not as easily displaced by freezing, and a deeper feeding ground for the roots is provided.

A mistake made more frequently than that of not putting the drains in deep enough is that of using too small tile. The character of the soil, the fall and the amount of surface drained are the factors which largely determine the proper size to use. Almost every book or bulletin of tile drainage gives tables for figuring the size of the required under various conditions. If there is any doubt it always pays to get a size too large rather than a size too small, even if the cost is a little more.

It is usually better to let the job of tiling to a contractor rather than to attempt to do it yourself. There are reliable tilers in almost every locality who can be depended upon to lay the tile to grade and do a first class job in

every particular. Only the hard baked tile should be used. These will last for a lifetime or longer if properly put in. When tile go within fifteen or twenty feet of trees the joints should be cemented. Otherwise the tree roots will find their way through the joints and fill up the drains to such an extent that the flow of water will be cut off. The most important part of a drainage system is the outlet. The tile should empty into a stream if possible. Water should not be allowed to stand over the mouth of the outlet if it can be avoided, as this checks the current and causes the drain to partly fill up with silt, thus reducing its capacity just that much.

With a thorough system of tile drainage in good working order the problem of getting rid of surplus water is solved. Tiling also helps to solve the problem of lack of water. The roots go down so much deeper in a tiled soil that they are in position to withstand a drought better than if they were a foot or two farther above the water table. Removing the surplus water by drainage also hastens the warming of the soil in the spring.

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